

In re Application of: Yair EIN-ELI et al
Serial No.: 10/551,714
Filed: July 20, 2006
Office Action Mailing Date: November 4, 2009

Examiner: PARVINI Pegah
Group Art Unit: 1793
Confirmation No. 6188
Attorney Docket: 30579

REMARKS

Reconsideration of the above-identified application in view of the amendments above and the remarks following is respectfully requested.

Claims 1-54 are in this case. Claims 52 and 54 have been withdrawn from further consideration as being drawn to a non-elected invention. Claims 23-25 have been canceled in response to the previous Official Action, filed on July 23, 2009. Claims 1-22 and 26-54, drawn to a composition useful for the formation of a passivating layer on a substrate, have been examined on the merits.

Claims 31-36 have been withdrawn from further consideration as being drawn to a non-elected invention. Claims 1-22, 26-30 and 53 have been rejected. Claim 1 has been amended herewith. New claims 55-59 have been added herewith.

Election/Restriction

The Examiner has stated that amended claims 31-36 are directed to an invention that is independent or distinct from the invention originally claimed.

Specifically, the Examiner has stated that claims 31-36 are drawn to a method of forming a passivating layer on a surface, grouped under Group IV. The Examiner has referred to Groups I, II and III, addressed in the Election Restriction mailed on December 5, 2008, and has stated that Groups I, II, III and IV do not relate to a single general inventive concept, since the special technical feature is a composition used to form a passivation layer on a substrate, such as copper or copper alloy substrates, in which the composition has a pH of preferably between 2 to 12 and not having film-forming agent, and this special technical feature is taught by U.S. Patent No. 6,447,371.

Applicant respectfully traverses the Examiner's statement regarding the special technical feature, for the reasons set forth hereinbelow. Accordingly, Applicant asserts that the special technical feature is not taught in the art.

The Examiner has further stated that since Applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits, thus, claims 31-36 are withdrawn from consideration as being directed to a non-elected invention.

Information Disclosure Statement

The Examiner has stated that with reference to the IDS submitted on June 2, 2009, citations 1, 2, and 3 were crossed out and not considered.

Applicant will soon re-submit, under separate cover, this Information Disclosure Statement accounting for the aforementioned discrepancies.

35 USC § 103 rejections

Brusic Kaufman et al. alone or in view of Haggart et al.

The Examiner has stated that claims 1-12, 26-30 and 53 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,447,371 (Brusic Kaufman et al.), either alone or in view of U.S. Patent No. 6,589,099 (Haggart, Jr. et al.). The Examiner's rejections are respectfully traversed. Claim 1 has been amended herewith.

Regarding claim 1, the Examiner has stated that Brusic Kaufman et al. teach a first and a second CMP slurries for forming a passivation layer on a substrate such as copper, wherein the first CMP slurry, having a pH of from about 2.0 to about 12.0, comprises an oxidizing agent such as hydrogen peroxide, or a permanganate, etc., an abrasive such as silica, alumina, or others in an amount of 0.5 to 15.0 wt %, and that the Brusic Kaufman et al. disclose overlapping ranges of amounts of abrasive and pH of the slurry with the instantly claimed slurries, and overlapping ranges have been held to establish *prima facie* obviousness.

With specific reference to the limitations drawn to oxidation potential of the slurry, the Examiner has noted that the reference discloses a CMP slurry having an overlapping range of pH containing similar abrasives and oxidizers used for polishing copper substrate by forming a passivation layer onto said substrate; therefore, the oxidation potentials as recited in claim 1 is seen a characteristic naturally following from the composition of the disclosed slurry of Brusic Kaufman et al. absence clear and specific evidence showing why said reference composition does not have or could not impart an oxidation potential which would meet the limitation of claim 1, and that in the alternative, it would have been obvious to one of ordinary skill in the art through routine experimentation in the art in order to optimize the oxidation potential

based on the intended polishing rate since a reduction in oxidation potential would slow down the polishing rate as is known in the art as depicted by Haggart et al..

The Examiner has stated that although Brusic Kaufman et al. disclose the use of complexing agents in the slurry, they do not disclose the use of copper complexing agents, and considering the recitation of instant claim 1 which recites "being devoid of a film-forming agent, a copper complexing agent and/or ammonium cations" would make it clear that the teaching of Brusic Kaufman et al. on the optional presence of film-forming agent would read on the limitation of instant claims.

With specific reference to the composition being devoid of ammonium, the Examiner has noted that instant claim 1 recites "being devoid of a film-forming agent, a copper complexing agent and/or ammonium cations", thus, meaning that the composition need to be devoid of only either of the indicated ingredient/component, and when considering the fact that Brusic Kaufman et al. make it clear that the existence of film-forming agents is optional, said limitation is assumed to be met absence proving to the contrary, and that in the alternative, even though Brusic Kaufman et al. may disclose the use of other agents, such as ammonium salts, they are all embodiments of the present reference which means that none of them are components that must be present in the disclosed CMP slurry.

Before referring to the Examiner's rejection, Applicant wishes to set forth again the underlying basis of embodiments of the invention, since Applicant is of the opinion that this may have been which seems to be overlooked.

As presented in the instant application, embodiments of the present invention relate to the provision of compositions and methods of using the same for *passivating copper without exposing metallic copper in the process*, namely, passivating and polishing the surface of copper mechanically and not chemically while having a layer of copper oxide present at all stages throughout the CMP process. Thus, while prior-art CMP slurries, including those taught in the reference raised by the Examiner, are designed and practiced with copper corrosion (oxidation) in mind, namely designed to perform a chemical reaction wherein metallic copper is exposed and corroded to an oxide, the slurries taught by the instant application are not meant to corrode copper.

Embodiments of the present invention thus relate to *compositions which prevent chemical corrosion of copper* by following the rational extracted from the

Pourbaix diagram (a potential/pH diagram) presented in Figure 1 of the instant application, which can be expressed in either oxidation potential or pH, the correlation of which is condensed into the equation: $P_{pH} = -0.05 \times pH + 0.425$, presented on page 6. Thus, the most effective pH range is selected following the rational of "*not to corrode copper*" over the entire range presented in the Pourbaix diagram, showing that at pH values lower than 9, the desired function will not be obtained since copper is corroded by a slurries having pH lower than 9. Similarly, pH higher than 13 causes etching of copper, thus the workable non-corrosive pH range is 9-13.

The following arguments and statements are to show and provide support to the distinctive feature of the present invention, that all the prior-art composition are meant to be corrosive with respect to copper as part of their intended characteristics, while the presently claimed compositions are specifically non-corrosive to copper.

Applicant submits that embodiments the present invention are directed at CMP slurries for forming a passivation laver on a copper substrate which are formulated at a particular pH range. The compositions taught by the present invention are based on a clear and substantiated rational, and with suitable components that afford meeting the requirements of that rational. The Examiner's attention is kindly drawn in this regard to the passage on page 10, line 17-21, which opens the discussion on the underlining rational of the presently claimed CMP slurries. This passage speaks of the non-obvious analysis of the Pourbaix diagram (a potential/pH diagram) presented in Figure 1 of the instant application, which maps out possible stable (equilibrium) phases of an aqueous electrochemical system of copper and other metals. The passage on page 10, lines 22-28 presents the connection between the pH of the system containing copper, and the sufficient oxidation potential for passivation of copper, which is then expressed by the equation presented on page 11, line 9, of the instant application.

As further discussed on page 10, line 29 to page 11, line 6, the minimal pH of the copper passivating solution which would afford arriving at the minimal oxidation potential of the solution, was deduced by the present inventors from the Pourbaix diagram to be about 9-10, where the sufficient oxidation potential is more positive than about -0.05 volt relative to a saturated calomel reference electrode. Along this

rational, for a solution with a pH of between about 10 and about 11, a sufficient oxidation potential is more positive than about -0.1 volt, and so on.

This connection between the suitable pH range of the system and the desired end result of passivating copper is non-trivial since the Pourbaix diagram takes into account only the thermodynamics of oxidation (relative to a standard hydrogen electrode) and does not account for kinetic effects, and therefore the Pourbaix diagram can be considered as doing no more than assisting one skilled in the art to understand the rational underlining the present invention, and the experimental results presented in the instant application are necessary to arrive at the invention and reduce the invention to practice.

The passage on page 13, lines 9-13 of the instant application, presents the conclusion of the aforementioned analysis, namely that the preparation of a CMP composition involves preparing a solution having a pH equal to or greater than 9 and having an oxidation potential sufficient to oxidize a copper-containing surface to form copper oxides, wherein neither copper nor the formed copper oxides are substantially soluble in the composition.

The Examiner's attention is further directed to page 14, lines 1-22 of the instant application, where the investigation of the theory made by the present inventors and based on the analysis of the Pourbaix diagram in Figure 1, is presented. The unexpected results presented in the instant application provide support for the claimed range of pH values being 9 or higher.

On page 10, line 23-25, it is stated that from the Pourbaix diagram it is also seen that at pH above 13 copper is dissolved by the formation of soluble cuprite ions (CuO_2^-).

Applicant has chosen to amend claim 1 so as to read on a pH range of 9-13, based on the abovementioned supporting evidence presented in the instant application.

The Examiner's attention is directed to MPEP§716.02(d) which stipulates that when unexpected improved results are obtained within a range taught by the prior art, **such claim is not viewed as obvious in view of the prior art** when such results commensurate in scope with the claims which the evidence is offered to support.

Since, as further argued hereinbelow, Brusic Kaufman et al. teach compositions having a pH in a range of from 2 to 12, but fails to show any advantage,

let alone reduction to practice, of composition having a pH higher than 9, and since the instant application is based on the surprising effect that is exhibited at pH higher than 9, it is respectfully submitted that the claimed invention is both novel and non-obvious over Brusic Kaufman et al..

In sharp contrast to the present invention, Brusic Kaufman et al. teach compositions having a pH in a range of from 2 to 12. Brusic Kaufman et al., however, have not practiced compositions having pH higher than 7. Specifically, the compositions practiced according to the teachings of Brusic Kaufman *et al.* have pH 7, as stated clearly in all of the Examples described therein, (see, for example, Example 1 on column 12, lines 40-41, Example 2 on column 13, lines 37-39, and the last Example 3, Table 4 on column 14, where the three provided slurries are adjusted to pH 7, 6 and 5, respectively, and are therefore *acidic* slurries, no less).

In addition, the slurries practiced in Brusic Kaufman *et al.* not only do not motivate any artisan to seek basic slurries for treating copper substrates as obvious alternatives, but rather teach away from basic slurries by using predominantly acidic components such as hydrogen peroxide and tartaric acid, which must be adjusted by considerable amounts of ammonium hydroxide in order to bring them up to less acidic or neutral pH (see, Example 1 on column 12, Example 2 on column 13 and Example 3, Table 4 on column 14).

Referring to the Examiner's statement regarding the optional use of complexing agents and the optional presence of film-forming agent in the slurry of Brusic Kaufman et al., and the Examiner's statement regarding instant claim 1 which recites "being devoid of a film-forming agent, a copper complexing agent and/or ammonium cations" that would make the teaching of Brusic Kaufman et al. read on the limitation of instant claims, Applicant refers to the passage on page 13, lines 4-8, which describes why the absence of any agent that can promote dissolution of copper will afford superior CMP results, and hence Applicant has amended claim 1 to recite that the slurries composition need to be devoid of each of the indicated ingredient/component, namely are devoid of each of a film-forming agent, a copper complexing agent **and** ammonium cations.

Hence, presently amended claim 1 recites:

In re Application of: Yair EIN-ELI et al
 Serial No.: 10/551,714
 Filed: July 20, 2006
 Office Action Mailing Date: November 4, 2009

Examiner: PARVINI Pegah
 Group Art Unit: 1793
 Confirmation No. 6188
 Attorney Docket: 30579

"A composition useful for the formation of a passivating layer on a surface, the surface including more than 5% copper by weight, the composition comprising a solution which has a pH ~~equal to or greater than~~ that ranges from 9 to 13, having an oxidation potential sufficient to oxidize the surface to form copper oxides and being devoid of a film-forming agent, a copper complexing agent and/or ammonium cations, wherein neither copper nor said copper oxides are soluble in the composition."

Applicant submits further, with regards to Brusic Kaufman et al. optionally using complexing agent and/or a film forming agent in their first composition, that it is non-obvious to be devoid of all such ingredients in view of Brusic Kaufman et al. since they teach that both their first composition and second composition contain a complexing agent and an ammonium-based agent, after stating that it is a more preferred mechanism wherein a thin abradable layer is continuously formed by reaction between the metal surface and one or more components in the slurry such as a complexing agent and/or a film forming layer (see, column 2, lines 63-66 in Brusic Kaufman et al.). It is expected that the teaching of Brusic Kaufman et al. will teach away from the present invention since it is not directed to copper but rather directed to other metal alloys, and requires compositions that exhibit other features.

Applicant therefore submits that the amended claim 1 is not rendered obvious by Brusic Kaufman et al. and is therefore allowable.

The Examiner has further stated that:

regarding claims 26-30, Brusic Kaufman et al. disclose the use of abrasive such as silica, alumina, or others in an amount of 0.5 to 15.0 wt %;

regarding claims 2-6, Brusic Kaufman et al. read on the instant limitation absence evidence showing that the surface of the substrate does not contain more than about 5 %, 10 %, 40 %, 50 %, or 80 % of copper;

regarding claims 7-12 and 53, with reference to the limitations drawn to oxidation potential of the slurry, Brusic Kaufman et al. read on the instant limitation absence clear and specific evidence showing why the composition does not have or could not impart an oxidation potential which would meet the limitation of claim 1; or

In re Application of: Yair EIN-ELI et al
Serial No.: 10/551,714
Filed: July 20, 2006
Office Action Mailing Date: November 4, 2009

Examiner: PARVINI Pegah
Group Art Unit: 1793
Confirmation No. 6188
Attorney Docket: 30579

on the alternative it would have been obvious to try to optimize the oxidation potential based on the intended polishing rate as depicted by Haggart et al..

In response, Applicant submits that the amendments now made to claim 1 clearly distinct the claimed CMP slurries composition from the teachings of Brusic Kaufman et al., either alone or in view of Haggart et al., and further with respect to each of the limitations recited in any of claims 2-6, 7-12, 26-30 and 53.

35 USC § 103 rejection

Brusic Kaufman et al. in view of Haggart et al. and Shimazu et al.

The Examiner has stated that claims 13-17 and 19-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brusic Kaufman *et al.* alone or in view of Haggart, Jr. *et al.* as applied to claim 1 above, and further in view of U.S. Patent Application Publication No. 2002/0017064 (Shimazu *et al.*). The Examiner's rejection is respectfully traversed.

Specifically, the Examiner has stated that Brusic Kaufman *et al.* alone or in view of Haggart, Jr. *et al.* disclose a CMP slurry having a pH of from about 2.0 to about 12.0, oxidizers such as permanganates, abrasives such as silica and alumina as detailed above, and although Brusic Kaufman *et al.* disclose the use of pH adjusters such as bases to adjust the pH, said reference does not expressly disclose that said base may be potassium carbonate.

The Examiner has further stated that it would have been obvious to one of ordinary skill in the art to modify the polishing composition to have included a pH adjuster such as potassium carbonate to control the rate of polishing copper substrate since bases such as potassium carbonate affects the rate of polishing copper by adjusting pH as that taught by Shimazu *et al.*, and that it would have been obvious that the two references are drawn to the same field of endeavor.

As argued above, Applicant contends that Brusic Kaufman *et al.*, alone or in view of Haggart, Jr. *et al.*, do not teach or motivate to arrive at the presently claimed invention.

Shimazu *et al.* teach a polishing composition comprising an alkaline substance which includes KOH or hindered amines. Applicant wishes to note that the nitrogen functionality in hindered amines is surrounded by sterically-hindering atomic

In re Application of: Yair EIN-ELI et al
Serial No.: 10/551,714
Filed: July 20, 2006
Office Action Mailing Date: November 4, 2009

Examiner: PARVINI Pegah
Group Art Unit: 1793
Confirmation No. 6188
Attorney Docket: 30579

environment. By teaching hindered amines as pH adjusters, Shimazu *et al.* teach away from the present slurries as presently claimed since hindered amines are known to form stable complexes with copper and in fact are used to dissolve copper oxide. Furthermore, Shimazu *et al.* teach the use of KOH which is not formed from an alkali cation and a weak acid anion, as taught in the instant application and claimed in claims 13-17.

It is therefore the Applicant's opinion that the presently claimed invention is not rendered unpatentable over Brusic Kaufman *et al.* alone or in view of Haggart *et al.* or Shimazu *et al.*, and is therefore allowable.

35 USC § 103 rejection

Brusic Kaufman et al. in view of Haggart et al., Shimazu et al. and Parker et al.

The Examiner has stated that claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Brusic Kaufman *et al.* alone or in view of Haggart, Jr. *et al.* and in further view of Shimazu *et al.* as applied to claims 1 and 13 above, and further in view of U.S. Patent Application Publication No. 2003/0212283 (Parker *et al.*). The Examiner's rejection is respectfully traversed.

Specifically, the Examiner has stated that Brusic Kaufman *et al.* as evidenced by Haggart *et al.* and in further view of Shimazu *et al.* disclose a CMP slurry having a pH of from about 2.0 to about 12.0, oxidizers such as permanganates, abrasives such as silica and alumina as detailed above.

The Examiner has further stated that even though the references as combined may not expressly disclose the use of cesium carbonate to adjust pH, the use of such compound to adjust pH would have been within the scope of a skilled artisan motivated by the fact that cesium carbonate is also a known alkali metal compound utilized in adjusting pH as that shown by Parker *et al.*; furthermore, Parker *et al.* teach the use of other compounds such as potassium carbonate in order to adjust pH in a solution, thus, suggesting that potassium carbonate and cesium carbonate are functionally equivalent, and that it is well settled that the substitution of one functionally equivalent compound for the other is well within the scope of the skilled artisan absent clear evidence showing the contrary.

In re Application of: Yair EIN-ELI et al
Serial No.: 10/551,714
Filed: July 20, 2006
Office Action Mailing Date: November 4, 2009

Examiner: PARVINI Pegah
Group Art Unit: 1793
Confirmation No. 6188
Attorney Docket: 30579

Parker *et al.* teach the activation or regeneration of a catalyst involving contacting a fresh catalyst or a deactivated catalyst with ozone. Parker *et al.* does not teach any CMP slurries or even any copper-related chemistry. Applicant contends that the mere inclusion of potassium carbonate and cesium carbonate in a list of potential pH adjusters does not provide any motivation to combine the teachings of Parker *et al.* with any other art that relates to CMP compositions. Applicant contends that Parker *et al.* do not teach substituting reagents for achieving a solution having pH greater than 9 for passivating copper, and therefore Parker *et al.* cannot be used as related art in combination with other references.

It is therefore the Applicant's opinion that the presently claimed invention is not rendered unpatentable over Brusic Kaufman *et al.* alone or in view of Haggart *et al.*, Shimazu *et al.* or Parker *et al.*, and is therefore allowable.

35 USC § 103 rejection

Brusic Kaufman et al. in view of Haggart et al. and Watts et al.

The Examiner has stated that claims 21 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Brusic Kaufman *et al.* alone or in view of Haggart, Jr. *et al.* as applied to claim 1 above, and further in view of U.S. Patent No. 5,897,375 (Watts *et al.*). The Examiner's rejection is respectfully traversed.

Specifically, the Examiner has stated that Brusic Kaufman *et al.* as evidenced by Haggart *et al.* disclose a CMP slurry having a pH of from about 2.0 to about 12.0, oxidizers such as permanganates, abrasives such as silica and alumina as detailed above.

The Examiner has further stated that although Brusic Kaufman *et al.* as evidenced by Haggart *et al.* disclose the use of permanganates oxidizers, they do not expressly disclose the use of an oxidizer such as potassium permanganate; but nevertheless, it would have been obvious to one of ordinary skill in the art to utilize potassium permanganate as the permanganate oxidizer used in Brusic Kaufman *et al.* as evidenced by Haggart *et al.* motivated by the fact that not only Brusic Kaufman *et al.* disclose that permanganates are utilized in their slurry as oxidizer, but also, motivated by the fact that Watts *et al.* clearly teach that potassium permanganate is a

known industrial oxidizer used in CMP slurry utilized to polish copper layers (see, Abstract in Watts *et al.*).

As argued above, Applicant contends that Brusic Kaufman *et al.*, alone or in view of Haggart, Jr. *et al.*, do not teach, or motivate to arrive at, the presently claimed invention.

While Watts *et al.* teach CMP slurry using potassium permanganate as an oxidizer, Watts *et al.* also teach the use of ammonium cations and copper-complexing agents such as triazoles, and, as argued hereinabove, by that preclude motivation to arrive at the claimed invention, and in fact teach away from the presently claimed CMP slurries.

It is therefore the Applicant's opinion that the presently claimed invention is not rendered unpatentable over Brusic Kaufman *et al.* alone or in view of Haggart *et al.* or Watts *et al.*, and is therefore allowable.

New Claims

New claims 55-59, have been added.

New claim 55 depends from amended claim 1, and reads on a composition as defined in claim 1, which consists of a cation of an alkaline metal cations or an alkaline earth metal, an anion of a weak acid, abrasive particles and an oxidizing agent. Claims 56-59 depend from new claim 55 and recite further definitions of the composition's components, similarly to those recited in claims 13-22 and 26-30.

Applicant submits that no new subject matter is included in new claims 55-59.

In re Application of: Yair EIN-ELI et al
Serial No.: 10/551,714
Filed: July 20, 2006
Office Action Mailing Date: November 4, 2009

Examiner: PARVINI Pegah
Group Art Unit: 1793
Confirmation No. 6188
Attorney Docket: 30579

In view of the above amendments and remarks, it is respectfully submitted that claims 1-12, 13-22, 26-30 and 55-59 are now in condition for allowance. Prompt notice of allowance is respectfully and earnestly solicited.

Respectfully submitted,

/Jason H. Rosenblum/

Jason H. Rosenblum
Registration No. 56,437
Telephone: 718.246.8482

Date: February 4, 2010

Enclosure:

- Request for Continued Examination (RCE)